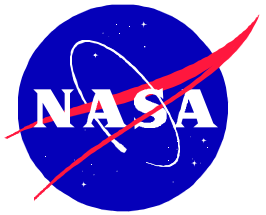


ESTO-TST Meeting
IT Road Map Presentation

Walt Brooks
NASA Ames Research Center

4/28/99

IT Roadmap for ESE

Outline

- Approach To Roadmap
- CNA Analysis-Mission, Instrument, Platform Drivers
- Architecture Analysis-NewDISS&Vision Drivers
- Supporting Programs-632 ,HPCC, SBIR, IT Base, ISE, IS, NMP, CEDTP, NMP,SOMO
- Example Roadmaps-Agency, ESE, IS, NMP,...

IT Roadmap for ESE

- **RFI-Broad National call for Ideas**
- **Leveraging and Analysis of relevant technologies in existing Programs**
  - HPCC/NGI -$50M-Agency Wide-Earth science grand challenges
  - IT Base-$50-60M- Code R funded research -possible synergy
  - ISE-$40-60M-agency wide-design environments
  - IS-$70 M- agency wide-top level roadmap developed and briefed by ARC
  - SBIR-Agency Wide -??
  - CETDP-632-$30M Agency Wide-IT technology some relevant info
- **Analysis of Derived Requirements-Mission & Architecture driven**
  - ESE Vision(M Ryschewitsch Team)-Initial concept developed and briefed
  - NewDISS(M. Maiden Team)- white papers emerging
  - Current EOSDIS lessons learned and technology program
  - EOSDIS and alternate Architecture Analysis
  - Capability Needs Assessment
- **Focused Workshops and Conference Sessions**
  - Data Mining/Fusion (ARC)
  - Data Storage(GSFC)
  - IPG
  - Digital Libraries

IT Roadmap for ESE

- **Develop Categories for ESE Roadmaps**
  - Relevant to emerging missions and architectures
  - Try to map to existing IT plans to minimize xwalk and translation

IT Roadmap for ESE

- Technology Categories-NASA Strategic Plan
  - **Advanced Miniaturization**
  - **Intelligent Systems**
    - Mission Apps--autonomous s/c and rovers, science data understanding,aviation ops, ISE
    - Cornerstones-Automated reasoning, Intelligent systems for Data understanding,HCC
  - Compact sensors
  - Self Sustaining Human Support
  - Deep Space Systems
  - ISE

IT Roadmap for ESE

- **Code R-IT Base**
  - **Integrated Design Technology-tools and environments, integrated instrumentation and testing**
  - **S/W Technology-Intelligent System Control and Ops, S/W integrity, productivity, security**
  - **Advanced Computing-adv computing networking and storage**
- **CETDP**
  - **High Rate Knowledge Delivery**
  - **Thinking Systems**
  - **Next Generation Infrastructure**
- **IS-Intelligent Systems**
  - **Automated Reasoning**
  - **Intelligent Use of Data**
  - **HCC**
  - **Revolutionary Computing**

IT Roadmap for ESE

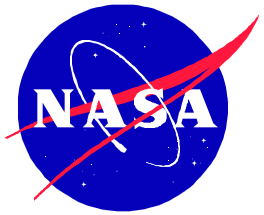
- **Example Technology sub Categories 632-CETDP Roadmap**
  - Devices and Nano Technology
  - On board Autonomy(rovers)
  - Analytic C&V for Space Missions
  - Intel. Deployable Execution Agents(IDEA)
  - Constraint Based Flex. Planning
  - Planning
  - Neural Control for Adaptive Space Systems
  - Model Based Programming Skunkworks
  - Persistent Cognizant S/W
  - HC Autonomous Agents
  - Super resolved 3-D surface Modeling
  - Artificial Collective Intell.
  - On Board Science analysis and decision making
  - Science Desk
  - Immersive Virtual Environments
  - Distributed Multi Robot Architect

IT Roadmap for ESE

- **Technology subcategories-ESE -Vision**
  - Reconfigurable sensing
  - On board Processing
  - Intelligent agents
  - Neural Processing
  - Distributed Information system in the sky
  - Adv. Engineering Environments
  - Autonomous Formation Flying
  - Intelligent discovery
  - Autonomous re-tasking
  - Distributed Tasking
  - Event anticipation
  - Research Agents
  - On board Monitoring
  - Active and passive data mining/prospecting
  - Self adapting learning
  - On board Information systems/Autonomy/Adv. Communications

IT Roadmap for ESE

- **Suggested Categories**
  - Autonomous S/C and Sensors
    - Automated reasoning,agents,planning and scheduling
  - Intelligent Use of Data
    - Storage,processing,DB Mgt,Algorithm development,s/w validation,calibration,Data Fusion & Mining, feature ID...
  - Scalable Computing
    - Networks,Storage,Archiving,Revolutionary Computing
  - Human Centered Computing



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IT Roadmap for ESE

- **Capabilities Needs Assessment-Technology Gaps**
  - On board -processing, storage, calibration, compression, channel identification
  - Autonomy-GNC, queuing, station keeping
  - Formation Flying
  - Automated Feature Identification,classification
  - Fault Tolerant Systems/graceful degradation
  - Smart Sensors

IT Roadmap for ESE

Critical technologies-Vision Architecture

- Reconfigurable Sensing
- Large Ultra-lightweight Deployable Structures
- Large Aperture Systems
- Large Deployable Systems: Ultra-high Resolution Imaging
- Rapid and Low-Cost Sensor Production
- New Vantage Points
- Miniaturized Observatories and Intelligent Web
- Onboard Processing
- Intelligent Agents
- Neural Processing
- Distributed Information-System-in-the-Sky
- Integrated Life Cycle Simulation
- Advanced Engineering Environment Enables the Rapid Production of New Capabilities

IT Roadmap for ESE

NewDISS Attributes

- Assumes 150Mb/sdata generation rate
- Flexible framework to integrate data services/ Heterogeneous,flexible adaptable
- Supports Persistence of data/ Preservation of low level and ancillary data
- PI Processing and Data management is core to new system
- **Web based data location and delivery system**
- Adapt **common interfaces** /Open published interfaces into data systems data sets and logarithms
- Broader User base /Absence of proprietary periods for data
- Competition at all levels for all elements

NEWDISS structure

- Mission Data centers-instrument satellite driven by PI or facility led
- Backbone data centers(DAACs)/Science data centers DAACs or ESIP derived
- R&A data centers
- Infrastructure components
- ESE long term archive
- Functions-**Archiving(ESE long term archive),Advertising,Query,Packaging**

IT Roadmap for ESE

- **Too Early in development to ID critical technologies**
- **NewDISS Strategy For IT**
  - Path 1 -joint development across community driven by PI needs
  - Path 2 -Tier 2 and 3 managers ID emerging technology and P-type
  - Technology development
    - Assess
    - P-type
    - Infuse
  - Develop benchmarks
  - S/W progress slow-push for CORBA I/F definition that will support legacy apps in any language
  - ID Gaps-partner with ESTO
  - NEWDISS could form a testbed for the longer term ESE Vision Concepts

IT Roadmap for ESE

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IT Roadmap for ESE

Supporting Pograms

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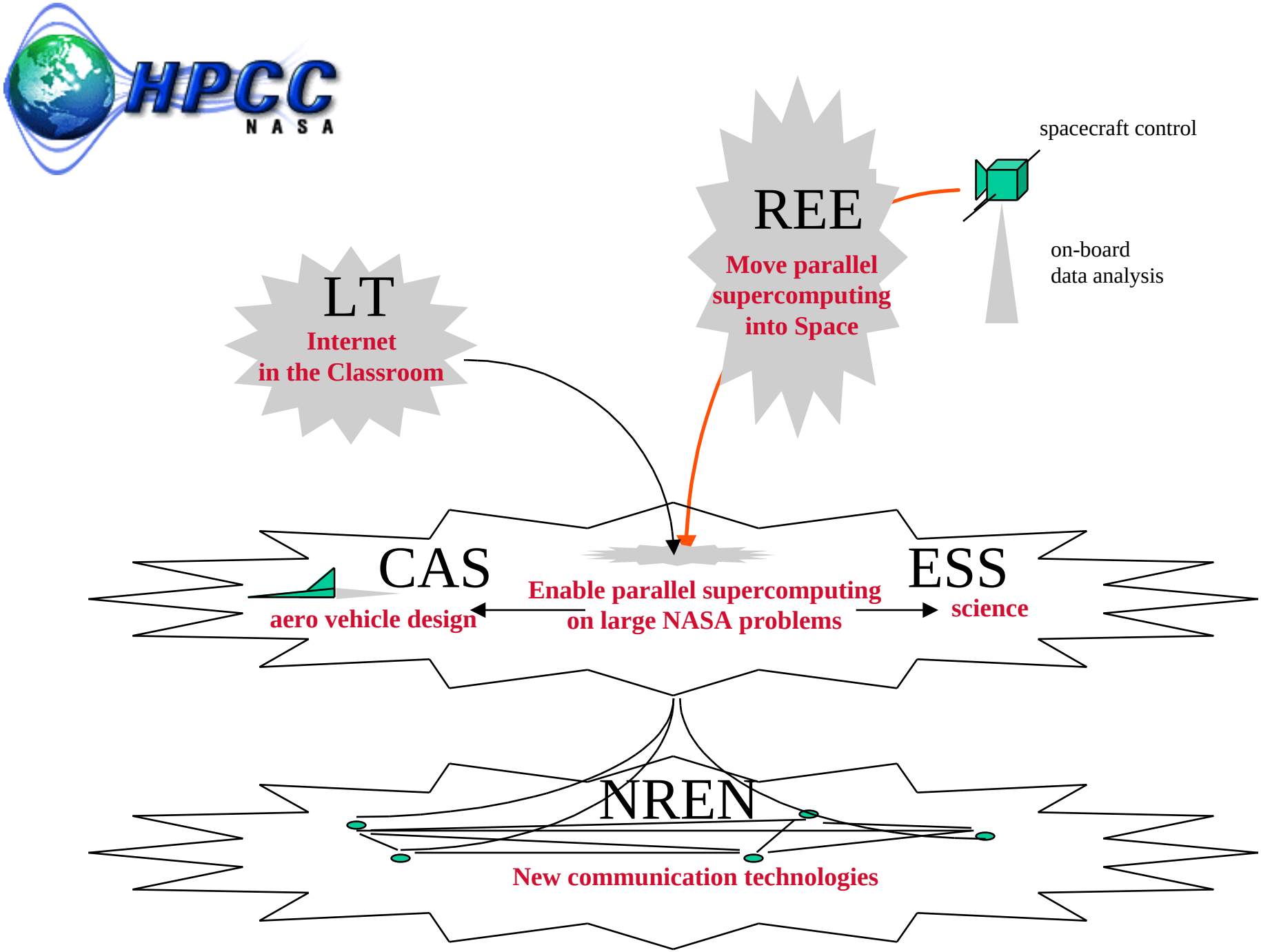
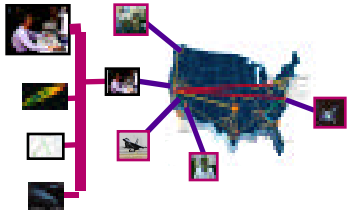
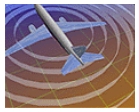
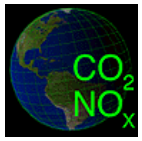
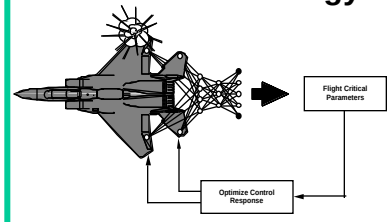
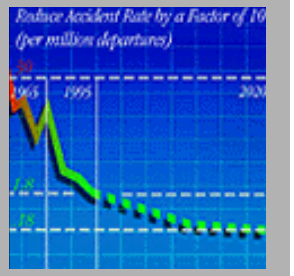
HPCC	**Agency high-performance computing and communications for 2005 timeframe (to enable Agency computing grand challenges)**
IT Base	**Computing and software technologies which specifically support Code R design and safety goals**
Cross-Cutting Technology	**Cross-Enterprise applications with primary focus on autonomy, as well as small investment in intelligent use of data and HCC**
ISE	**Technologies (exclusive of IS) necessary to revolutionize the complete life-cycle process of a product/mission**
IS	**Computer science/IT advances necessary to revolutionize both the design and science exploration activities of NASA, focusing on enhanced capabilities in automated reasoning, intelligent use of data, human centered computing, and revolutionary computing**

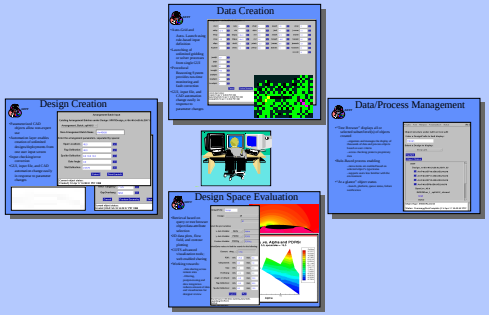

HPCC
NASA
spacecraft control
REE
Move parallel supercomputing into Space
on-board data analysis
LT
Internet in the Classroom
CAS
aero vehicle design
Enable parallel supercomputing on large NASA problems
ESS
science
NREN
New communication technologies

IT Base

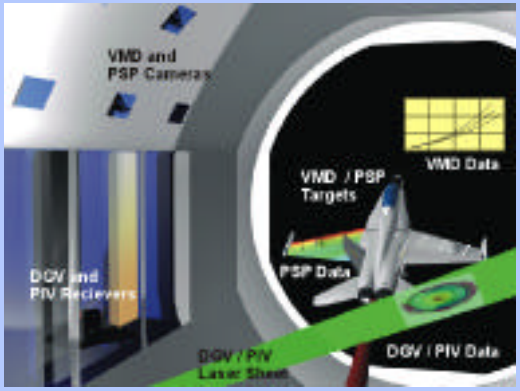
PROGRAM THRUST AREA	PRIMARY GOAL SUPPORTED	SECONDARY GOALS SUPPORTED
Integrated Design Technology 	 Design	 Affordability  Space Trans.
Advanced Computing Technology 	 Design	 Affordability  Space Trans.  High Speed   Noise & Emissions
Software Technology 	 Safety	 Affordability  Throughput

IT Base Program WBS

Integrated Design



519-10 Analytical Tools and Environments for Design
(ATED)

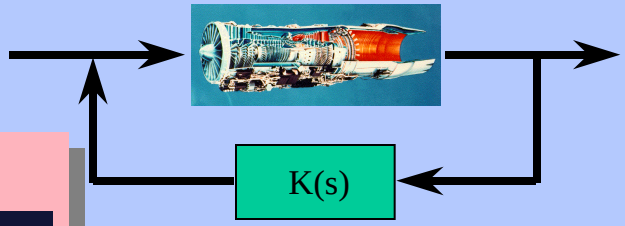


519-20 Integrated Instrumentation and Testing Systems
(IITS)

Advanced Computing

519-40
Advanced Computing, Networking & Storage
(ACNS)

Software



519-30 Intelligent System Controls and Operations
(ISCO)

519-50 Software Integrity, Productivity and Security
(SIPS)

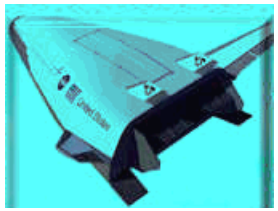
The ISE Functional Initiative

Rapid Synthesis and Simulation Tools

Developing advanced intelligence-based engineering and science simulation tools for analysis and design from concept through disposal and synthesis tools for seamless coupling of diverse discipline tools

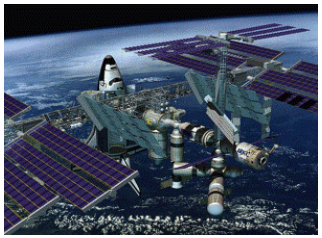
Cost and Risk Management Technology

Develop advanced cost analysis and risk tools in a unified framework covering end-to-end mission design, and compatible with design and analysis tools for fully integrated life cycle simulations.



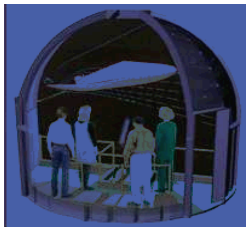
Life-Cycle Integration and Validation

Developing integration methods, smart interfaces and frameworks to achieve seamless “plug and play” integrated design and analysis, and assessment, validation and demonstration of ISE technologies.



Collaborative Engineering Environment

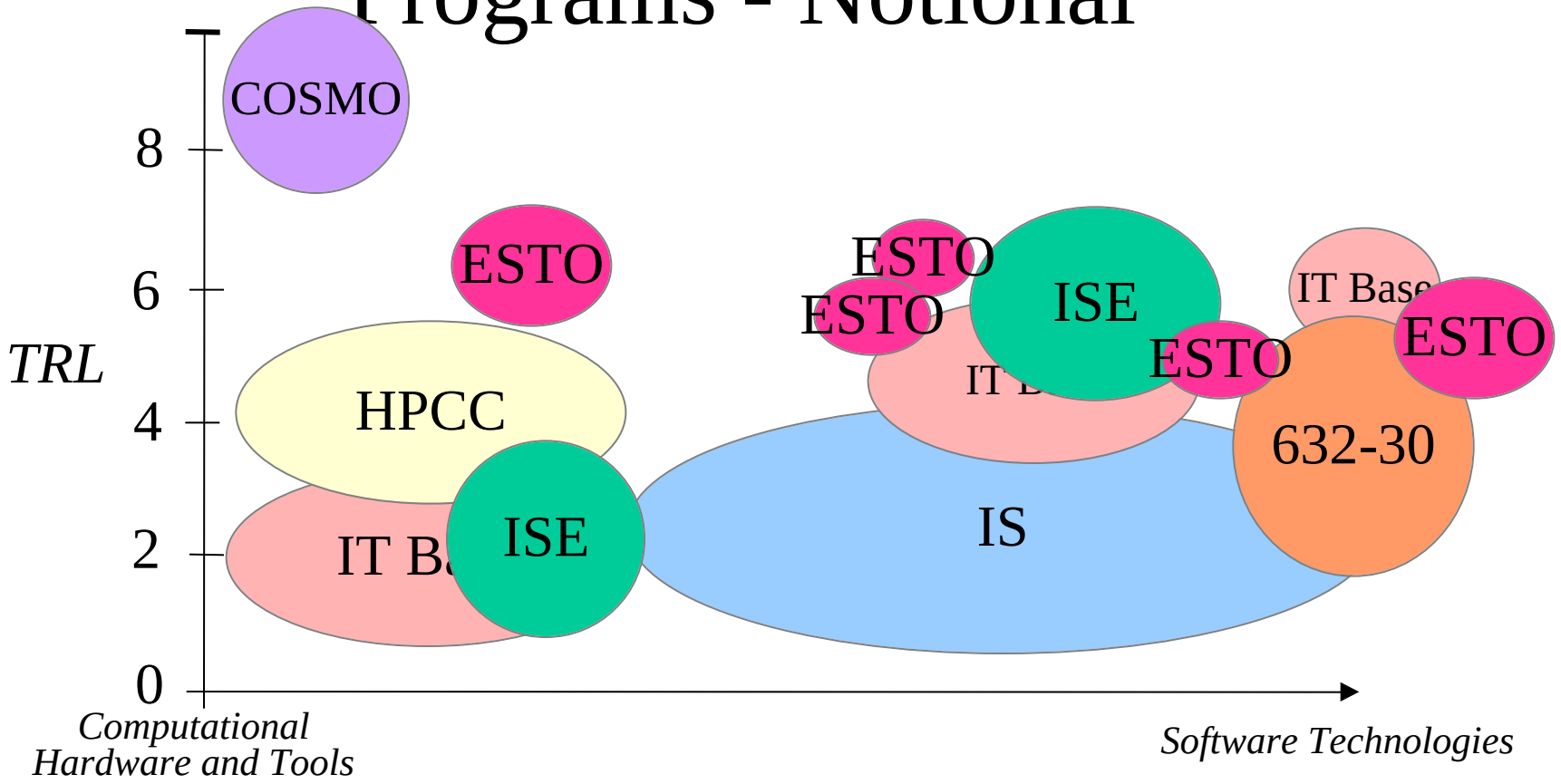
Advancing the state of practice and inserting the state of the art collaborative infrastructure and applied design and analysis capabilities into enterprise use.



Revolutionize Cultural Change, Training and Education

Changing the engineering culture to take full advantage of advanced tools and environments and developing distributed active learning and training collaborative environment

IT Technologies vs. NASA IT Programs - Notional



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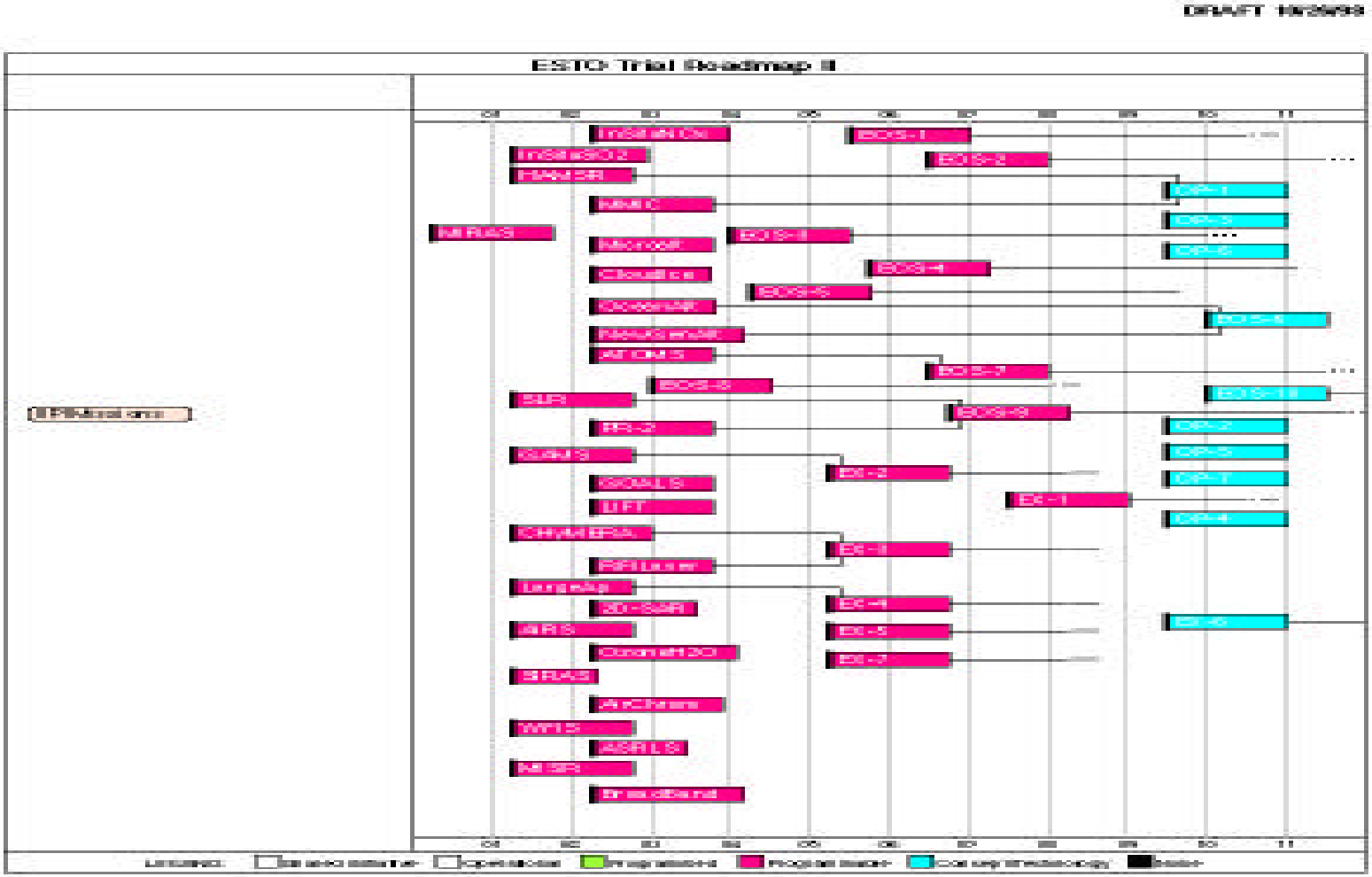
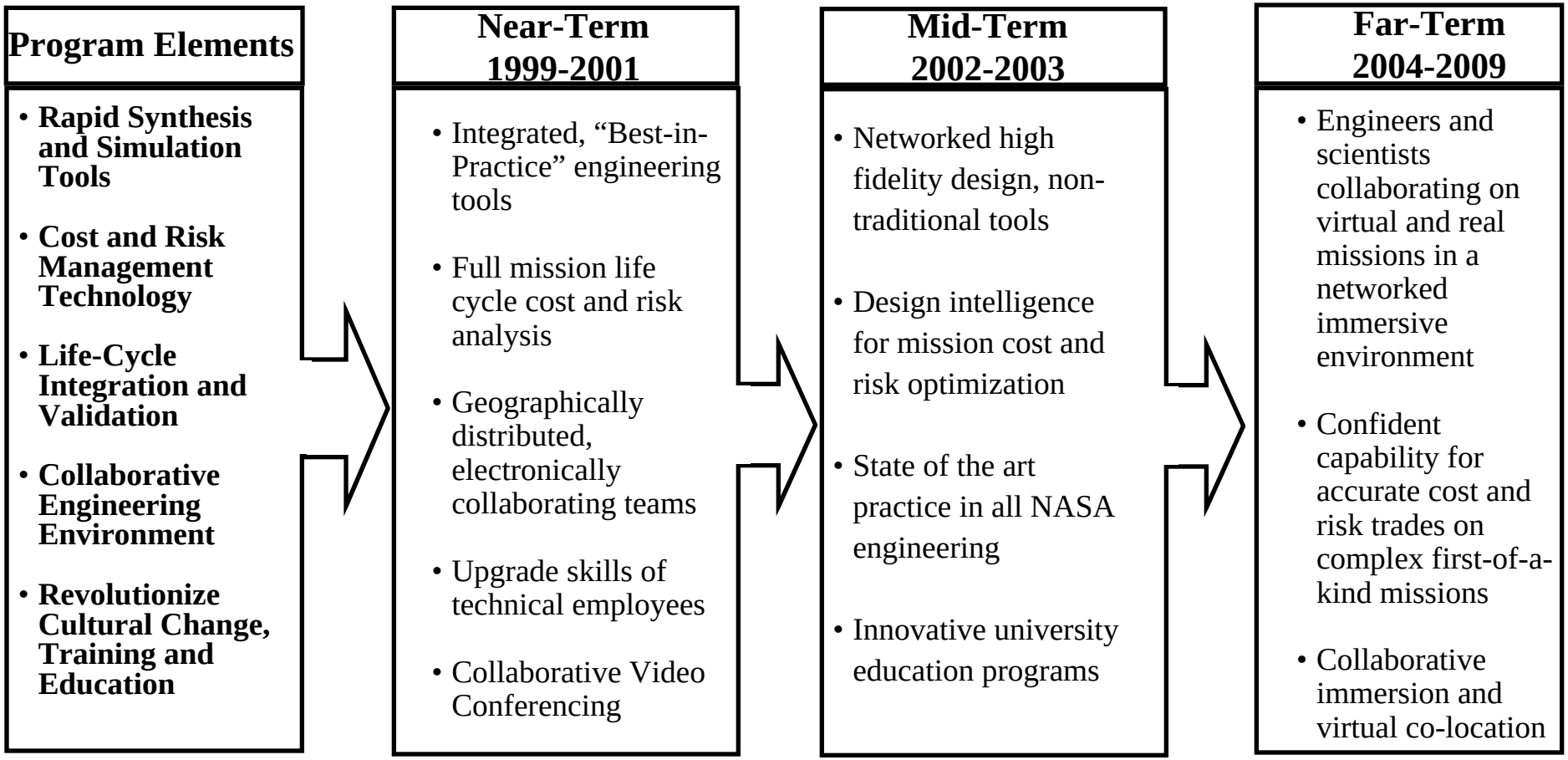
- **Example Roadmaps-Agency, ESE, IS, NMP**,...

Earth Science Technology



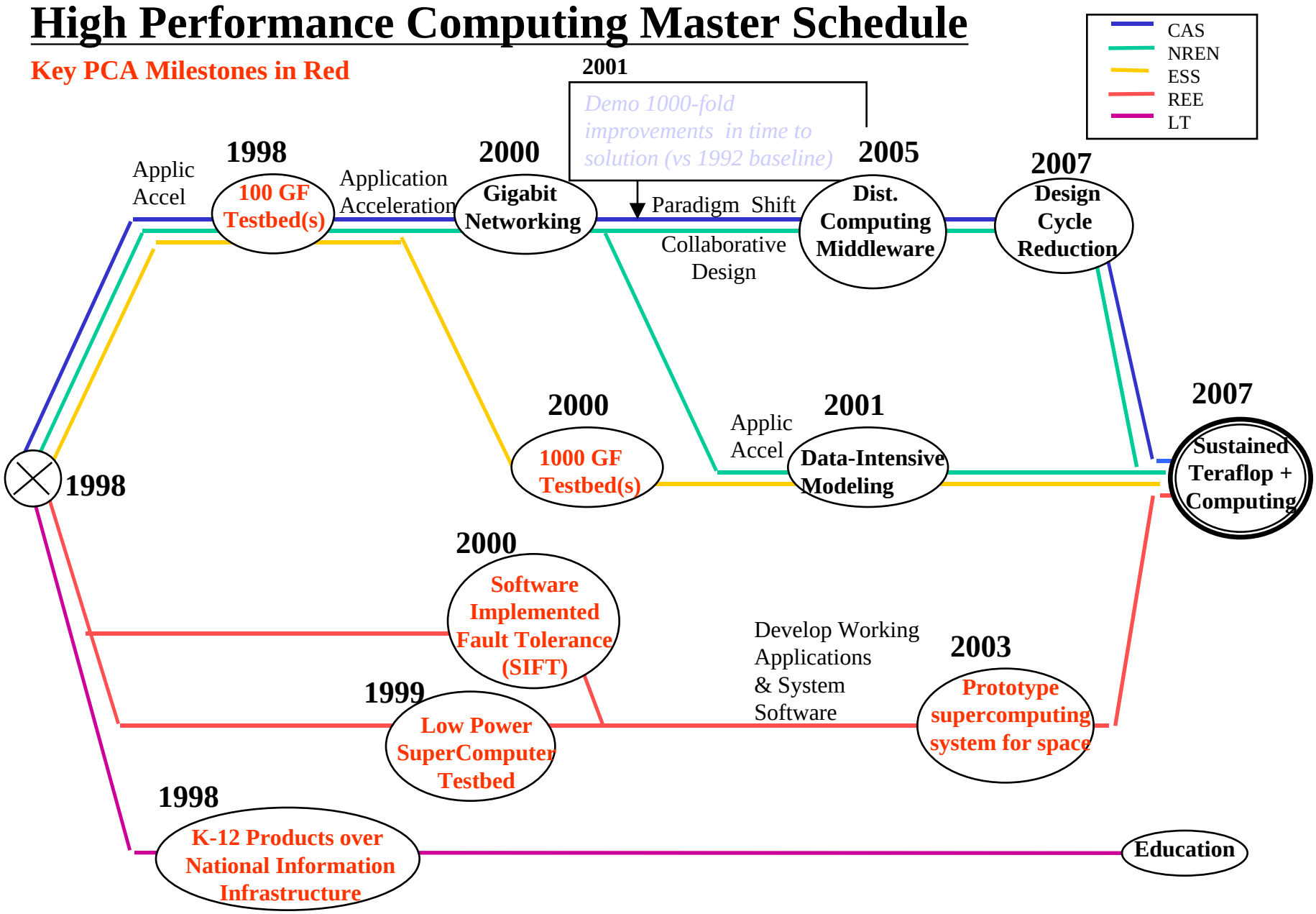
ISE Program Roadmap

Vision: To effect a cultural change that integrates widely-distributed science, technology and engineering teams to rapidly create innovative, affordable products.



High Performance Computing Master Schedule

Key PCA Milestones in Red

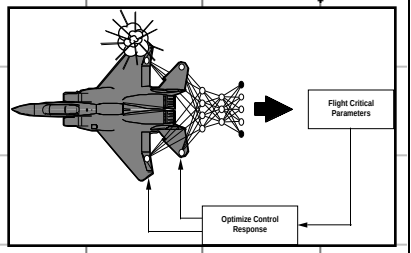


Integrated Milestones
Software Technology: 519-30 (ISCO), 519-50 (SIPS)

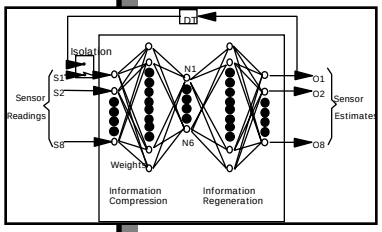
ID	Task Name
7	**Software Technology**
8	High reliability control demonstration of the AE3007 engine (3Q98)
9	Demonstrate neural based adaptive flight control technology (1Q99)
10	Develop verifiably-correct program synthesis technology for reduced time in software coding and testing (4Q00)
11	Prototype aviation safety information system demonstrated (4Q01)
12	Robust partitioning techniques for integrated modular avionics demonstrated (4Q02)
13	Develop and flight test intelligent flight/propulsion control (4Q03)
14	Demonstrate distributed control system and health monitoring technology for safe and robust aeropropulsion systems (4Q03)
15	Develop tools to ensure information integrity of National Airspace System data and communications (4Q03)

1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004

Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3

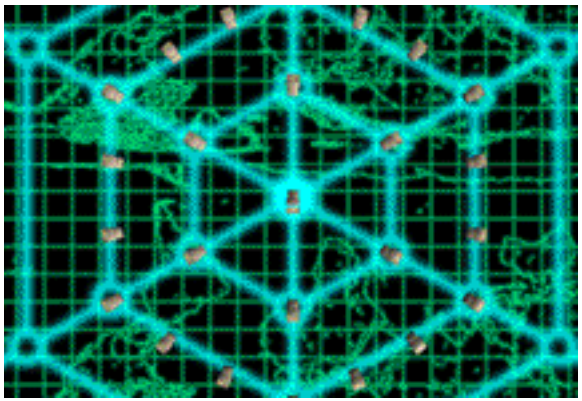


- **Milestone Completed**
  - **Non-real-time evaluation evaluation completed**
  - **Neural networks trained to detect sensor faults**
  - **I/O hardware acquired for real-time implementation**
  - **AE3007 real-time demonstration completed**
  - **Final report completed**

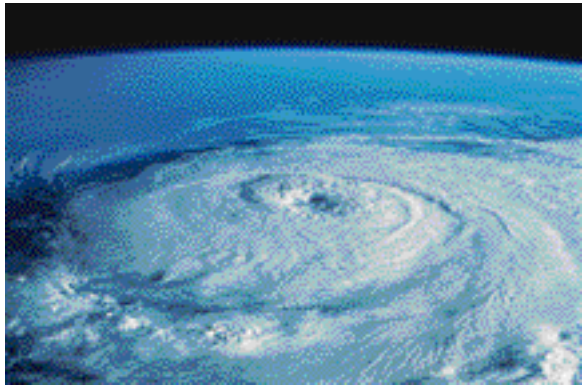


- **Milestone Delayed**
  - **Final version of real-time DCS neural net delivered to Boeing**
  - **Preliminary F-15 tests excellent**
  - **Incorporation into redesign F-15 flight controller in progress**
  - **10 Flight tests planned for 1Q99 delayed to 2Q99**

	5 years	10 years	15 Years
Autonomy	Attentive spacecraft with small ground teams	Curious spacecraft sensorweb aids opportunistic discovery	Cooperating spacecraft armadas
HCC	Human-machine interactive data dissemination	Real-time “wristwatch weather”	Virtual remote sensing presence
Data Understanding	Intelligent data fusion for trend correlation between models	Onboard calibration, data reduction, and analysis in Earth orbit	Spacecraft can identify features of opportunistic interest
Revolutionary Computing	Optical storage of optical images	National computing “Power Grid” for meteorological forecasting	Self-contained learning sensor packages for distributed measurements

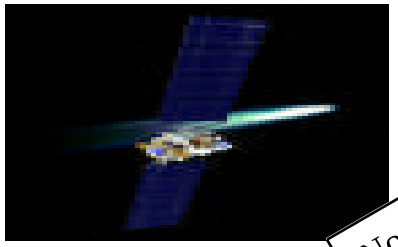


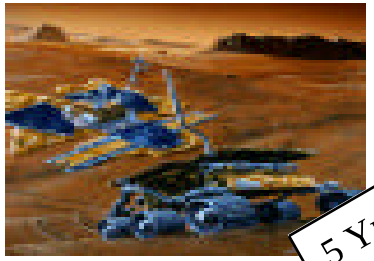
Integrated Observations, Models, and Analysis

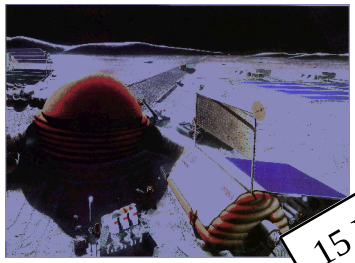


Forecast and Nowcast Storms

Cooperating Networks of Satellites







Application Missions:	**Data Chaser, DS1, DSN**	**RLV, Spaceliner, Mars 05**	**Mars Exploration, SIM**
Metrics			
Mission Complexity	• 1,000 tasks	• 10,000 tasks	• 100,000 tasks
Science Productivity	• 50% productivity	• 75% productivity	• 90% productivity
Mission Class	• 2 week DS flyby	• 1 yr rover mission	• virtual presence
Ground Ops Staff	• tens per mission	• tens, multiple missions	• scientists only

Objectives/Impacts:

- **Automated ground operations P&S systems**
- **Autonomous on-board P&S systems for remote missions**
- **Impact: Enable more challenging missions, improve science yield, and reduce ground staff required.**